EVALUATION OF TRAVEL MODEL SPEEDS AND PERFORMANCE OF EXISTING MONITORING SYSTEMS IN THE SOUTH COAST

Presented to:

Modeling Task Force

By:

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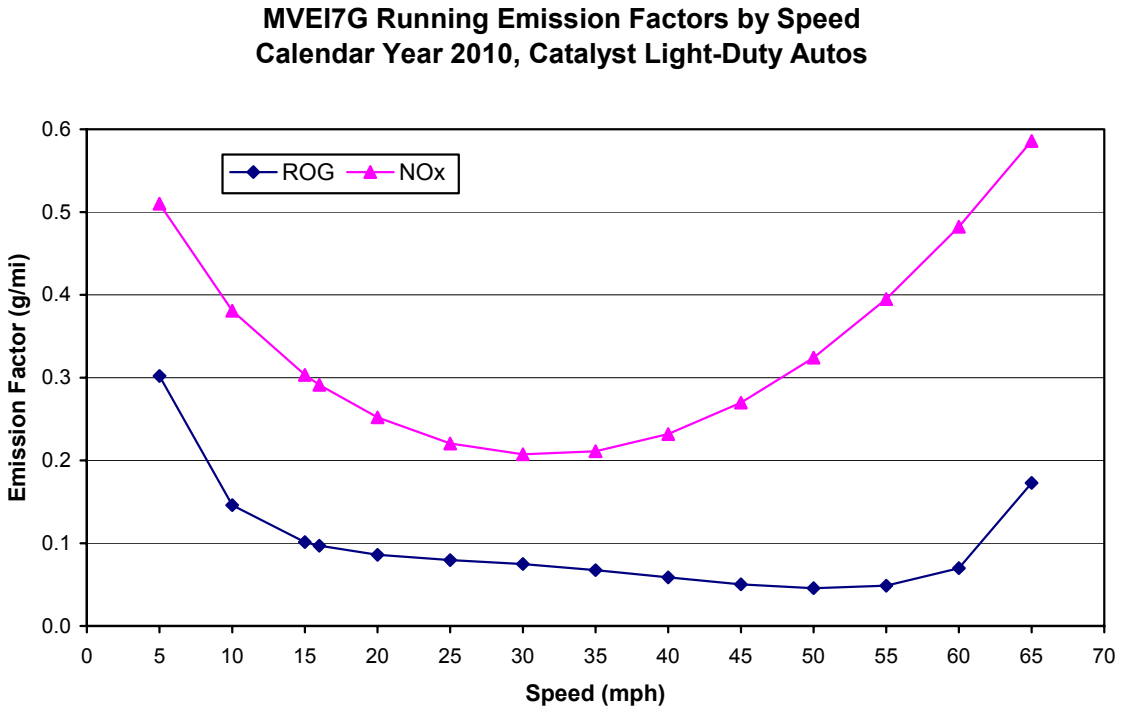
OVERVIEW

- Study objectives
- Review of existing systems and technologies
- Analysis of PeMS speeds
- Analysis of travel model speeds
- Summary of conclusions and recommendations

STUDY OBJECTIVES

Background

- The relationship between transportation and air quality planning and modeling has become more complex
- Travel model speeds are utilized to generate motor vehicle emission inventory estimates used in AQMP/SIP attainment demonstrations and transportation conformity determinations
- Recent improvements to SCAG's travel demand model have led to changes in speed estimates for both freeway and arterial roadways relative to the previous model
- Travel speed significantly affects vehicle emissions:



STUDY OBJECTIVES (cont.)

- A general lack of measured speed data exist to examine (and validate) travel model-predicted speeds

- Speed estimates from existing roadway performance monitoring systems may serve as a potential source for model validation

Objectives

- Evaluate existing sources of real world speed measurements in South Coast to:

  1. Validate speed/travel time estimates produced by SCAG model

  2. Track long-term changes and trends in network performance

Study Tasks

1. Review existing speed monitoring systems and measurement technologies

2. Compare PeMS speed estimates to chase car speed measurements on freeways

3. Compare SCAG travel model speeds to chase car speed measurements on both freeways and arterials

EXISTING MONITORING SYSTEMS REVIEW

Available Speed Measurements for The South Coast					
Measurement Systems	Road Types Covered	Technology	Time Periods Represented	Validation	Availability
PEMS	Freeways	Loop Induction	1/1/98 – Present	Dual Loop System in Berkeley	Internet Website
ATSAC	Arterials	Loop Induction	Most recent two week period	Floating Car & Laser Studies	Contact LA Dept. of Transportation
Caltrans Chase Car Studies	All	Custom Speed Sensor, Laser Rangefinder and GPS	Fall 2000, Fall 2001	Duplicate Measurements from Second Chase Car	Contact Caltrans
ARB GPS Studies	All	Differential GPS	Last 3-4 years	Differentially corrected position data	Contact ARB

EXISTING MONITORING SYSTEMS REVIEW (cont.)

Summary of Findings	
System	Key Findings
PEMS	• Uses adaptive "g-factor" methodology to translate flow and occupancy into speed estimates • Provides lane-specific information • Raw data collected at 30-second intervals • Data available 24/7 since 1998 from over 3,000 loops covering over 800 freeway miles in District 7 • Potentially attractive source of freeway speed
ATSAC	• Loops located at intersection approaches to aid in signal timing optimization • Speed estimates are "point in space" values • LA City estimates speeds accurate to ± 5-10 mph and speed validation studies are limited • Data currently archived for most recent two week period • Not viable source of arterial link speeds at this time
Caltrans Chase Car Studies	• Second-by-second speeds measured by following randomly selected vehicles • Fall 2000 study collected measurements over 100 OD-based road routes, driven twice each (covered mixture of roadways) • Fall 2001 study focused intensive sampling of three freeway corridors in Los Angeles/Long Beach (I-105E/W, I-110N) • Data collection was not optimized for model speed validation
ARB GPS Studies	• In-house research designed to develop a GPS instrumentation package and turnkey analysis system to measure vehicle speed and trips • Speeds measured from a limited set of vehicles instrumented in conjunction with ARB Surveillance Program • Spatial processing necessary to identify roadways and times vehicles were driven under "deployed" study • Initial spatial processing system not fully reliable

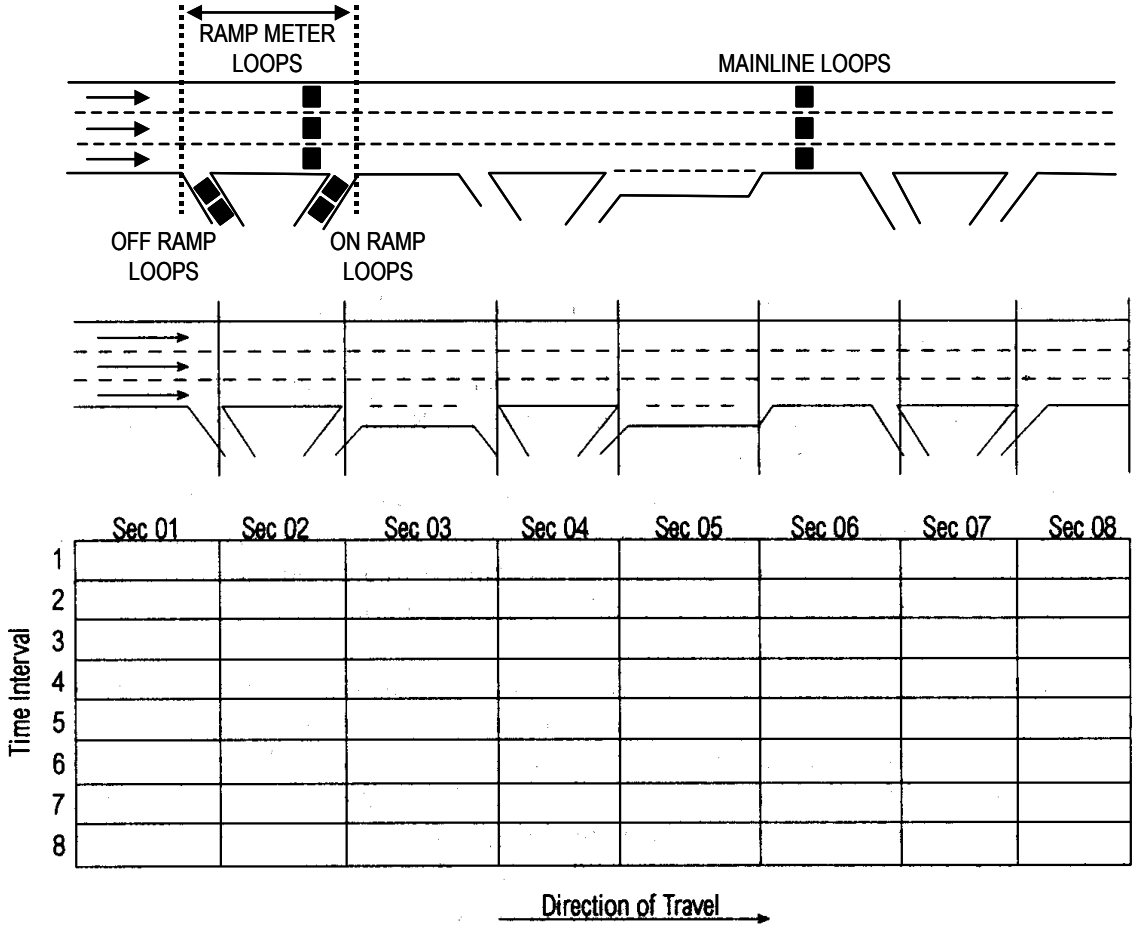
ANALYSIS OF PEMS SPEEDS

- Chase car speed measurements from Fall 2001 freeway study were compared to PeMS speeds from mainline loops along I-105E, I-105W and I-110N corridors

- Chase car speeds were measured from 8:00 AM to 9:30 PM on nine midweek days during mid-November

- Measured speeds were compared to PeMS speeds obtained from UC-Berkeley/PATH on a 5-minute basis

- The spatial basis for comparison was defined by segmenting each freeway corridor into "sections" (consistent with HCM)



ANALYSIS OF PEMS SPEEDS (cont.)

- Freeway sections represent a similar roadway length to freeway links defined in SCAG's modeling network

- The average speed measured by the chase car as is traversed each section was compared to the PeMS speed for the 5-minute period during which the traverse occurred

- This approach was favored over an instantaneous chase car speed comparison because of the ultimate goal of validating modeling link speeds

- Comparisons were performed by lane for sections which contained mainline loops (28 out of 40)

- The resulting analysis dataset contained over 4,500 paired (chase car vs. PeMS) speed observations

ANALYSIS OF PEMS SPEEDS (cont.)

Summary of Speed Comparisons by Freeway Route and Daily Period

		105 E		105 W		110 N
		AM[b]	Midday[c]	AM[b]	Midday[c]	PM[d]
Sample Size[a]		565	1173	572	1503	689
Average Speeds (mph)						
PeMS Speed	Mean (StdErr)	55.05 (0.56)	50.23 (0.47)	52.58 (0.54)	57.81 (0.24)	63.44 (0.11)
Chase Car (CC) Speed	Mean (StdErr)	66.80 (0.37)	61.91 (0.39)	55.62 (0.61)	64.07 (0.21)	67.98 (0.23)
Speed Comparisons (mph)						
CC-PeMS	Mean (StdErr)	11.75 (0.58)	11.67 (0.41)	3.04 (0.38)	6.27 (0.27)	4.55 (0.26)
	t value prob>t	17.6 < 0.01	19.2 < 0.01	3.7 < 0.01	19.6 < 0.01	17.6 < 0.01
Normalized Difference (CC-PeMS)/CC	Mean (StdErr)	0.16 (0.02)	0.17 (0.01)	0.02 (0.01)	0.09 (< 0.01)	0.06 (<0.00)
PeMS>CC	Number (%)	67 (11.9%)	202 (17.2%)	196 (34.3%)	296 (19.7%)	170 (24.7%)
CC>PeMS	Number (%)	498 (88.1%)	971 (82.8%)	375 (65.6%)	1206 (80.2%)	519 (75.3%)

[a] Number of speed pairs (chase car, PeMS 5-minute data)

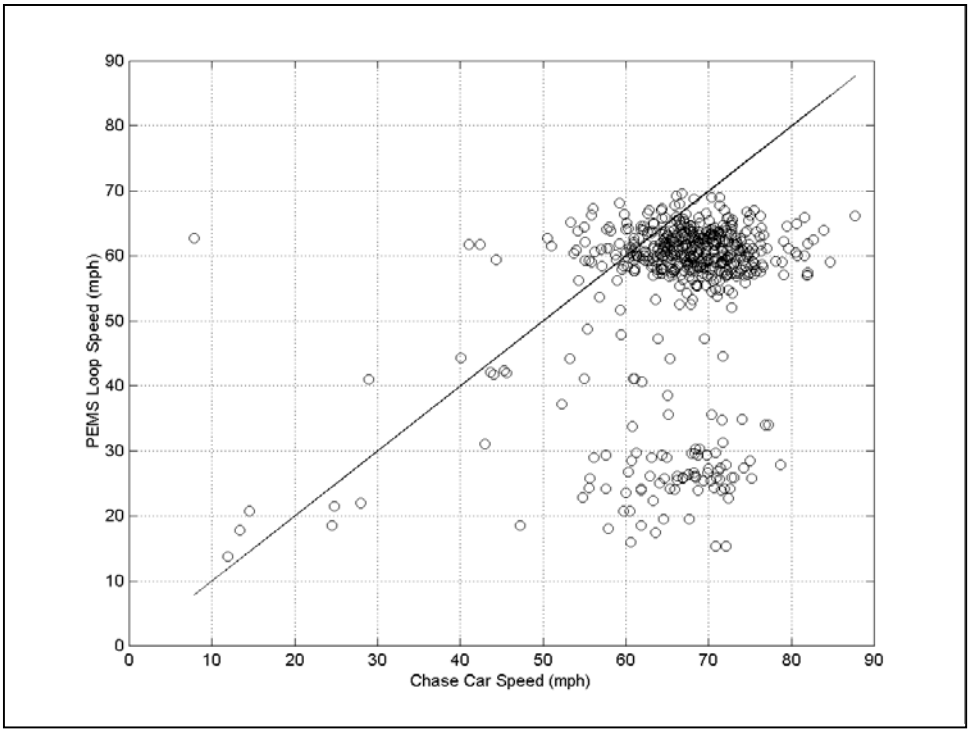
[b] Defined as the 8:00 to 10:00 AM sampling period

[c] Defined as the 11:30 AM to 2:30 PM and 4:00 to 5:30 PM sampling periods

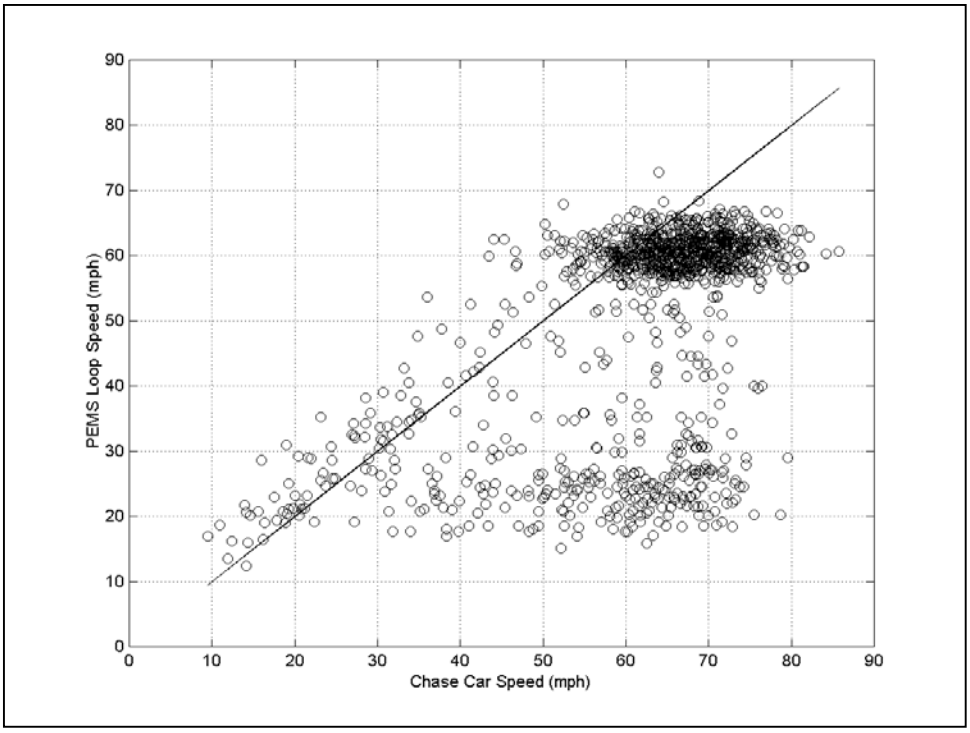
[d] Defined as the 5:30 to 9:00 PM sampling period

ANALYSIS OF PEMS SPEEDS (cont.)

Chase Car and PeMS Speeds for I-105E AM Period

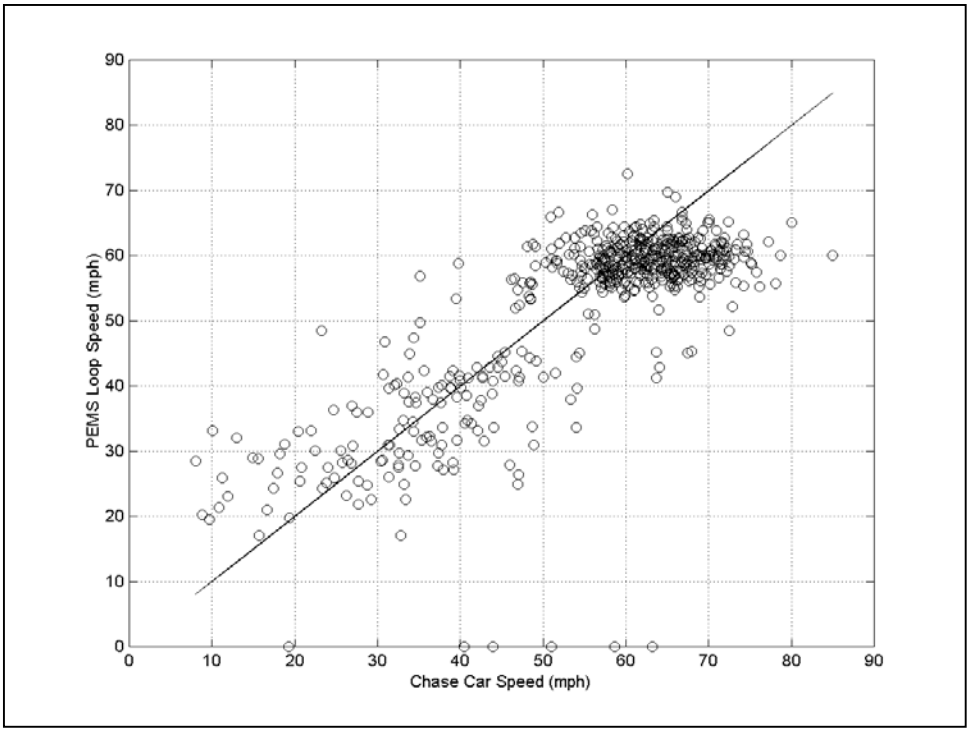


Chase Car and PeMS Speeds for I-105E Midday Period

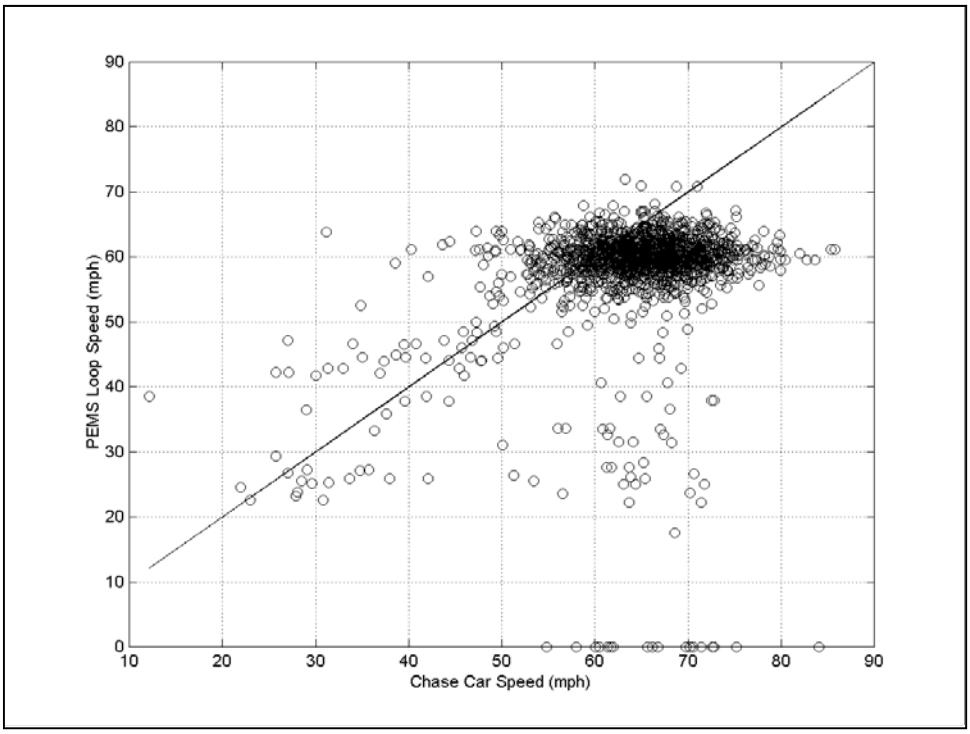


ANALYSIS OF PEMS SPEEDS (cont.)

Chase Car and PeMS Speeds for I-105W AM Period

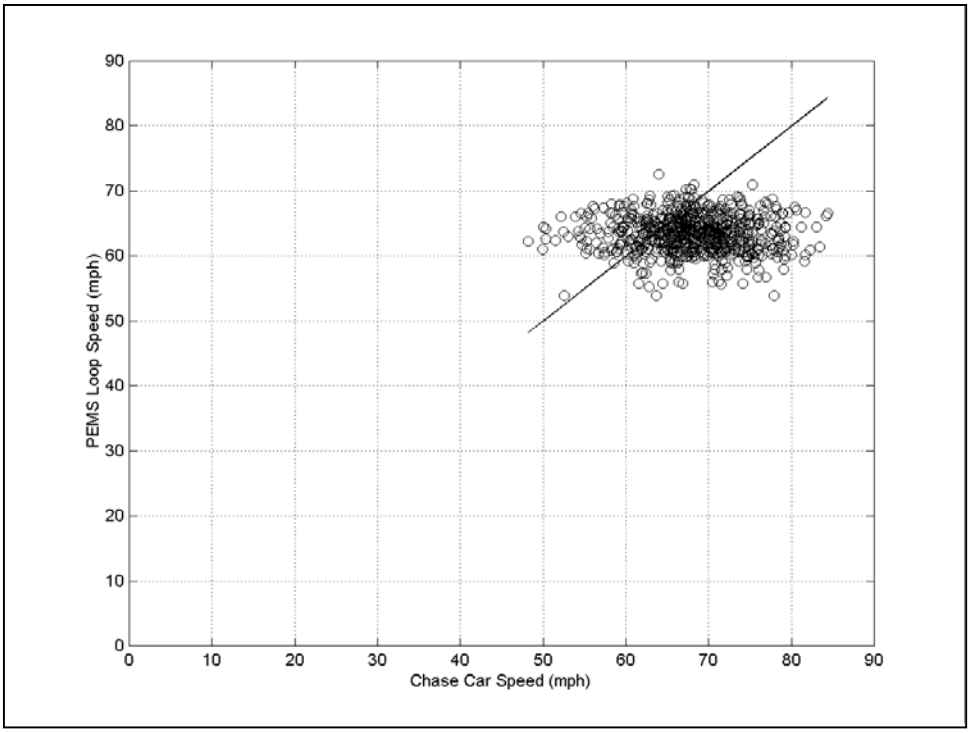


Chase Car and PeMS Speeds for I-105W Midday Period

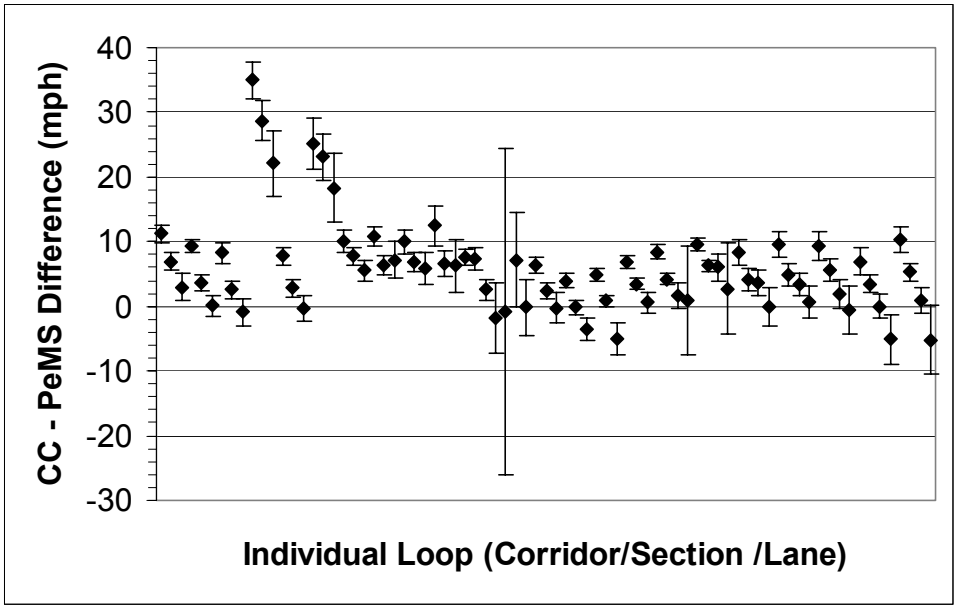


ANALYSIS OF PEMS SPEEDS (cont.)

Chase Car and PeMS Speeds for I-110N PM Period



Speed Differences by Individual Loop



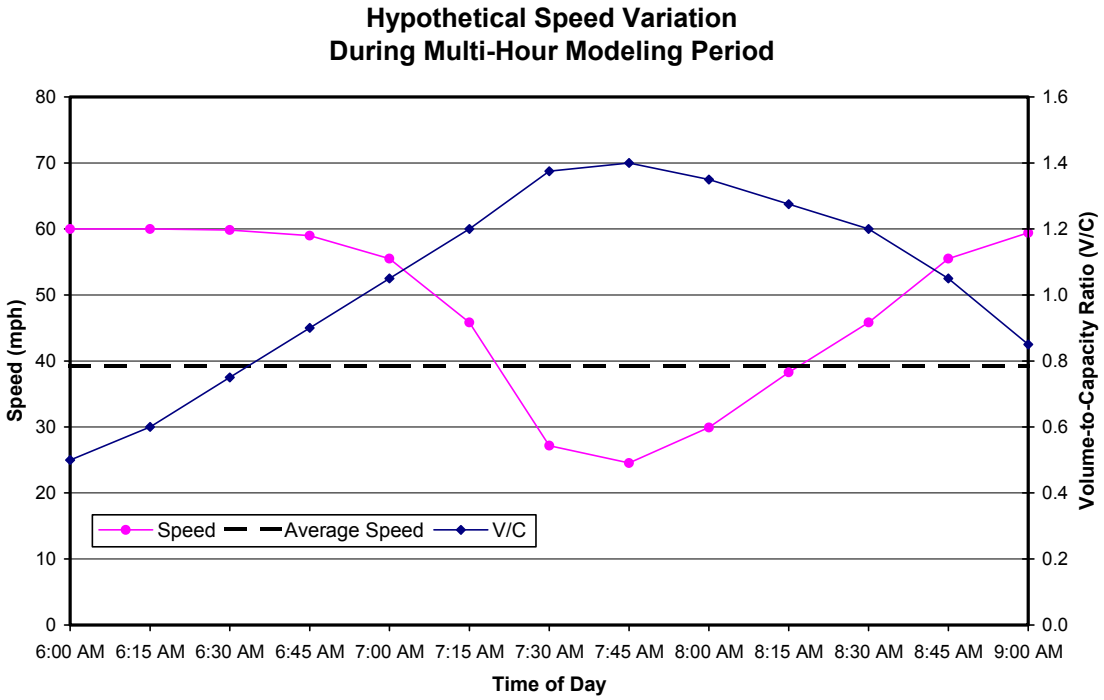
ANALYSIS OF PEMS SPEEDS (cont.)

Difference in Speeds as a Function of Lane Number (Chase Car Speed - PeMS Speed)						
		105 E		105 W		110 N
		AM	Midday	AM	Midday	PM
ML Lane 1	N	230	474	198	557	179
Chase Car Speed	Mean	70.21	64.89	59.10	67.27	72.54
PeMS Speed	Mean	54.87	50.25	54.47	57.65	63.66
Speed Difference	Mean (StdErr)	15.34 (0.90)*	14.65 (0.63)*	4.63 (0.56)*	9.62 (0.44)*	8.88 (0.47)*
ML Lane 2	N	239	482	280	694	273
Chase Car Speed	Mean	65.25	61.41	54.17	62.94	67.94
PeMS Speed	Mean	55.04	50.71	51.42	57.91	63.30
Speed Difference	Mean (StdErr)	10.21 (0.87)*	10.71 (0.63)*	2.75 (0.58)*	5.04 (0.35)*	4.64 (0.36)*
ML Lane 3	N	96	216	93	243	175
Chase Car Speed	Mean	62.50	56.44	52.67	60.09	65.31
PeMS Speed	Mean	55.54	49.10	52.31	57.86	63.16
Speed Difference	Mean (StdErr)	6.96 (1.32)*	7.34 (0.95)*	0.37 (0.84)	2.22 (0.73)*	2.15 (0.47)*
ML Lane 4 N	N	0	1	1	9	62
Chase Car Speed	Mean	-	-	-	60.74	62.54
PeMS Speed	Mean	-	-	-	57.98	64.16
Speed Difference	Mean (StdErr)	- -	- -	- -	2.76 (2.56)	-1.62 (0.84)

* Difference is statistically significant at the 0.05 level or better.

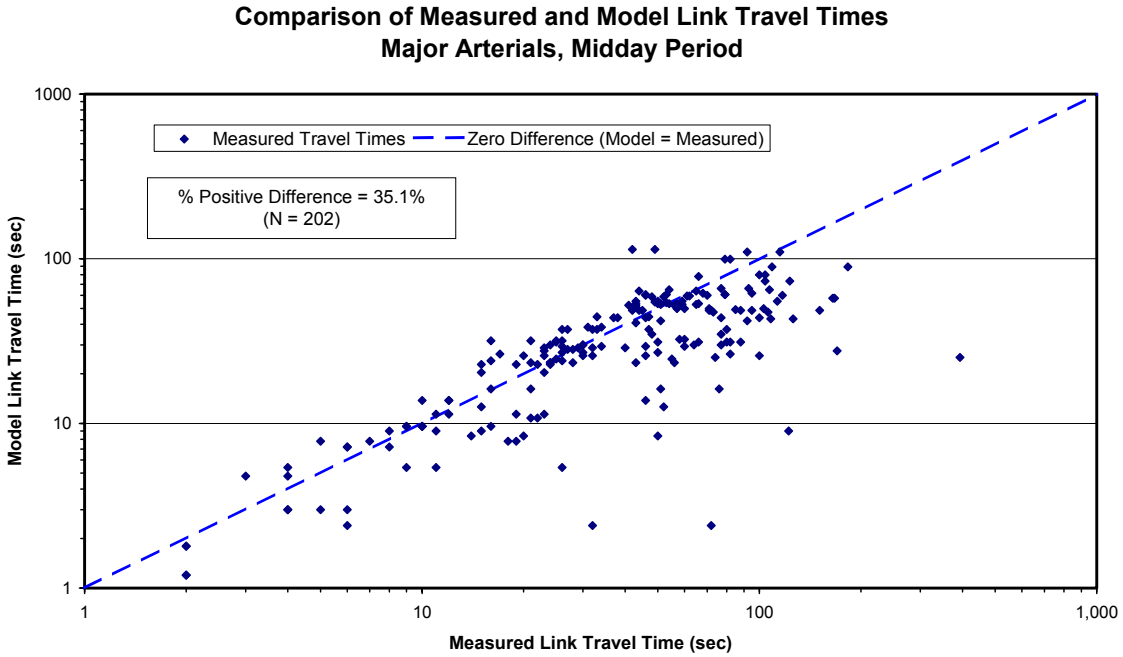
ANALYSIS OF TRAVEL MODEL SPEEDS

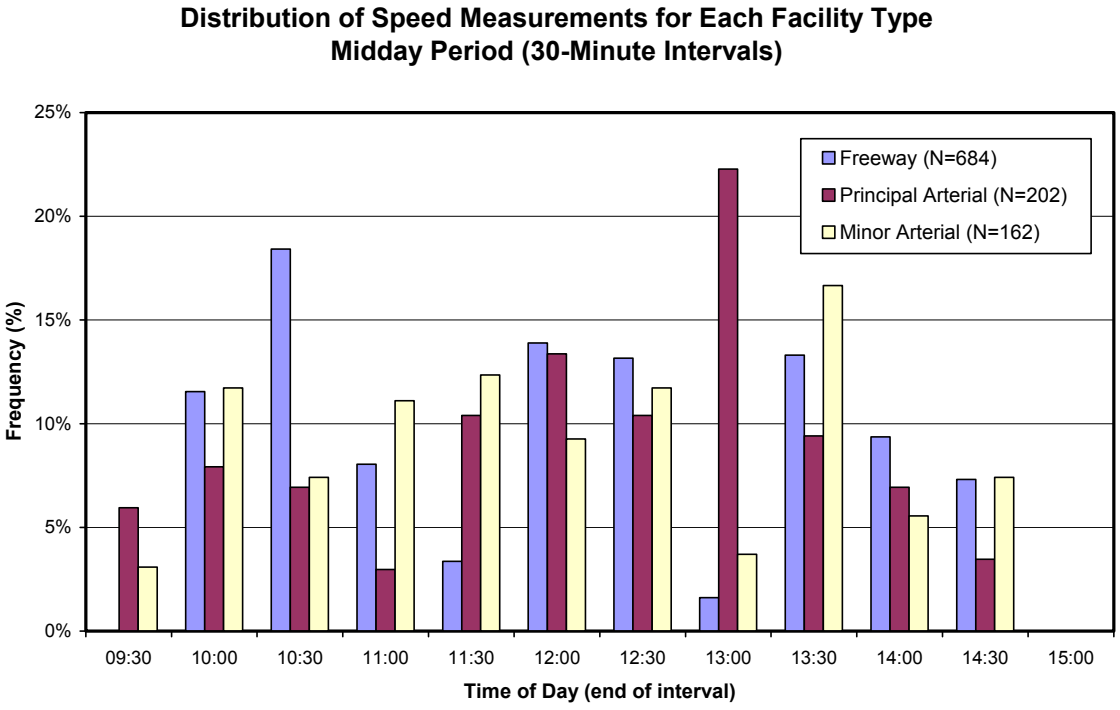
- Chase car speed measurements from the Fall 2000 route-based driving study were compared to link speeds from SCAG model
- Spatial processing was performed to compute average chase car speed as it traversed each link
- A total of roughly 1300 link speed measurements were obtained, covering a mixture of freeways and arterials and times of day
- Few repeat observations (~2-4) were available for each individual link
- Since chase car speeds were compared to single model speed for each multi-hour modeling period, in-period variation had to be addressed:



ANALYSIS OF TRAVEL MODEL SPEEDS (cont.)

- The data were grouped by facility type (freeway or arterial) to address small sample sizes and in-period variation





ANALYSIS OF TRAVEL MODEL SPEEDS (cont.)

- Statistically significant quantitative conclusions could not be drawn
- However, qualitative comparisons indicate the model may:
    - Under-predict midday freeway speeds
    - Over-predict midday and PM major arterial and midday minor arterials speeds

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- Review of available speed monitoring systems shows there is no single source that routinely covers all roadways
- PeMS is an attractive source of continuous freeway data
- Chase cars provide very accurate speed measurements, but coverage is limited and not routinely collected
- Comparative analysis of PeMS loops along three freeway corridors indicates PeMS consistently under-estimates actual speed measured by chase cars between 3 and 12 mph
- Further refinement of g-factor algorithms and data filtering is needed before PeMS data could be used for validation of SCAG model
- Limited chase car measurements indicate possible biases in SCAG model speeds

Recommendations

- A sample size analysis must be conducted to define minimum dataset required to account for in-period, vehicle-to-vehicle and day-to-day speed variations and enable statistically-significant model validation
- Coordinate with Caltrans and Berkeley/PATH on mechanisms to improve PeMS speeds and routinely obtain data from the system
- Develop a program for regular collection of speed measurements on arterial roads